Preliminary Introduction of NSMC in the Monitoring of Precipitation and Flooding Area with NOAA/AVHRR Data

Fang Zongyi Lu Naimeng Liu Cheng
National Satellite Meteorological Center, CMA
Beijing 100081, China

The rainfall estimation and flooding area monitoring with meteorological satellite data are the two major tasks of National Satellite Meteorological Center (NSMC) among all of its services, as they are closely related with the water resources. In this paper, it gives a brief introduction of the work.

1. Precipitation monitoring

NSMC was intended to provide estimates of convective rainfall beyond the range of calibrated radar in 1986. Using NOAA satellite data, we developed a rainfall estimate technique based on the cloud top temperatures to monitor the precipitation over regions of Tibet, where few or no human activity existed. Although the early work only focused on case studies, it was an important step for the developing of NSMC operational rainfall estimate technique.

From 1988 through 1994, quite a few of scientists visited NOAA/NESDIS successively to joint research projects in the field of mesoscale analysis and satellite rainfall estimation. Meanwhile, a rainfall estimation program was being in progress in mainland China. Combined the results together, a convective rainfall estimation technique was developed in 1994. This technique derived rainfall intensities with a series of cloud characteristics, which included cloud top temperatures, temperature gradients, the expansion of convective cloud cluster, the occurrence of overshooting tops etc.(an introduction of this technique is enclosed herewith). The rainfall estimate systems based on this technique have been installed in 60 Middle Scale Data Utilization Stations over 28 provinces and they are used operationally in summer season.

Now, we are trying to use spilt window data of GMS-5 as well as the FY-2 geostationary satellite data to improve our current rainfall estimation technique. Preliminary results show that the spilt window channels do have additional information for rainfall monitoring, and better estimations, both for rainfall intensities and for rainy areas, can be expected (abstract enclosed).

Satellite derived rainfall is not only useful for synoptic and climatic analyses, but also valuable for hydrological uses. With the increasing awareness of the importance of satellite rainfall estimation, intensive research work have been done in NSMC. we hope to carry out an international cooperation in the field of rainfall estimation with SHMI, and expect to apply rainfall estimation products to flood monitoring and weather nowcasting.

Rainfall estimate technique for convective cloud

First, all convective clouds are divided into two categories of developing and disappearing. Secondly, considering the cloud sensitivities varying with cloud top temperatures, we divided convective clouds into segments according to their temperatures (Table 1). All samples falls into four segments. Linear regression are applied to the segments respectively (eight groups) in two geographical regions. The regression variables chosen are cloud top temperatures, the gradients of cloud top temperature, and the NRDs. The NRD means the normalized distance from a cloud covered pixel to the cloud cluster center. Fig.1 is the flow diagram for our rainfall estimate.

Table 1 Critical value of segments

segment	1	2	3	4
gray scale	203-219	220-228	229-236	>236

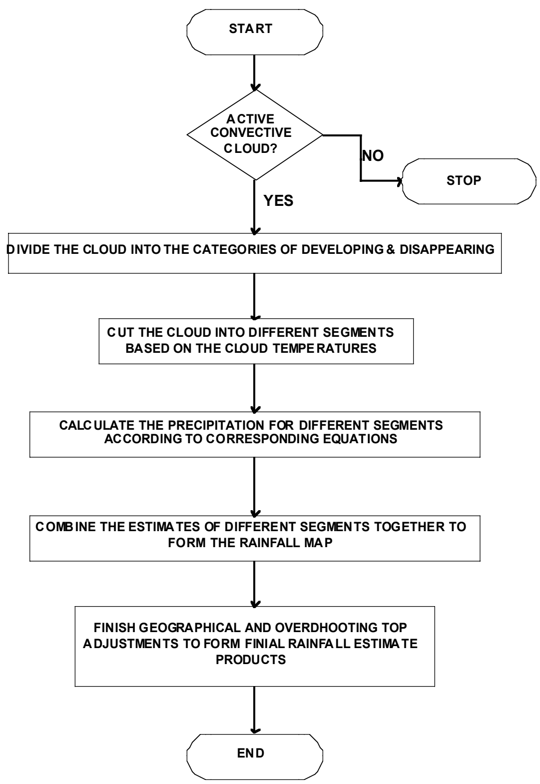

Fig.1 The flow diagram for hourly rainfall estimate technique developed by NSMC

Conclusion

Satellite rainfall estimate is a significant method for rainfall measurements. Compared with conventional gauges data, it can provide real-time information. Moreover, the satellite divided rainfall amounts are the only data we can get over oceans and deserts. The rainfall estimate Technique developed by the scientists in NSMC have been used in summer seasons. Its results revealed that its error is 30% for daily maximum rainfall estimate, and their correlation coefficient is 0.69 in our terrain and orographical regions. It is reasonable to guess that this technique will perform better when applied in plains where the weather systems are relative uniform. However, there are some problems still exist in satellite rainfall estimates:

1) Low spatial resolution. In middle latitudes, the area of one pixel covers tens of square kilometers in which the convective rainfall activities as well as the rainrates can be quite different.

2) Convective cloud top temperatures do not express rainrates physically. Compare to radar and microwave methods that can detect the droplets in clouds, the satellite rainfall estimates are more difficult.

3) The terrain effects have to be considered in the rainfall estimates.

2. Monitoring of flooding area

Identification of the types of land cover in remote sensing image is mainly based on the spectral characteristics. The flood in China is mostly occurred in the period from late spring to early autumn every year. At that time, the land features are mainly composed of water, vegetation and soil, the spectral characteristics of them are shown in fig. 2. In the near infrared waveband of NOAA/AVHRR, the water surface has a lower reflectivity while the ones for vegetation as well as other types of land surface are higher.

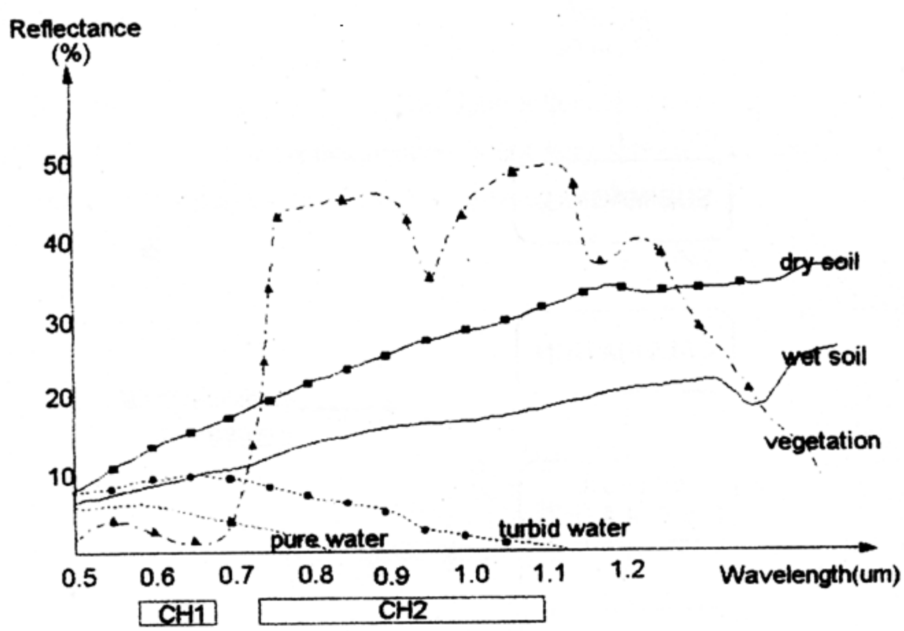

Fig.2 Typical Spectral Reflectance Curve for Water and Land

In the summer of 1998, a large region in China was attacked by severe floods. The flooded areas are mainly concentrated in the Yangtze River Basin and the Nen Jiang River Basin. During the time, NSMC closely monitored the floods with the data from NOAA satellites and provided many useful information to the related Government Departments.

NSMC began to monitor the flood from early May and seven major river basins including the basins of the Yangtze River, Yellow River etc. were monitored in daily operation. The whole monitored region were divided into 15 sections. Fig. 3a and fig. 3b are the images of May 25 and August 25, 1998 that show the status of the Dong Ting Lake before and after the flooding. The flooding area of the Po Yang Lake is presented in fig. 4a and 4b, and the fig. 5a and 5b are the flooding area of the Nen Jiang River.

Based on the continuous monitoring with the NOAA/AVHRR data from May to October of 1998, the statistics of the size of water body in above mentioned three areas were done by NSMC. The changes of the flooding coverage with time for the three areas are shown in fig. 6a, 6b and 6c respectively.

References

[1]⎈ Arkin, P. A. and R. Xie, 1994: The global precipitation climatology project: First algorithm intercomparison project. Bull. Amer. Meteor. Sec. 75, 401-419

[2]⎈ Lu Naimeng and Wu Rongzhang, 1997: Strong convective cloud characteristics derived from satellite cloud picture. Quarterly J. Appl. Meteor., 8(3), 269-275

[3]⎈ Lu Naimeng, 1997: Satellte rainfall estimate. The 1997 EUMESAT meteorological satellite users' conference

[4]⎈ Scofield, R. A. and Lu Naimeng 1994: The use of satellite imagery during the great floods of 1993. American Meteorological Society ninth conference on the middle atmosphere

[5]⎈ Scofield, R. A. 1987: The NESDIS operational convective precipitation estimation technique. Mon. Wea. Rew., 115(8), 1773-1792